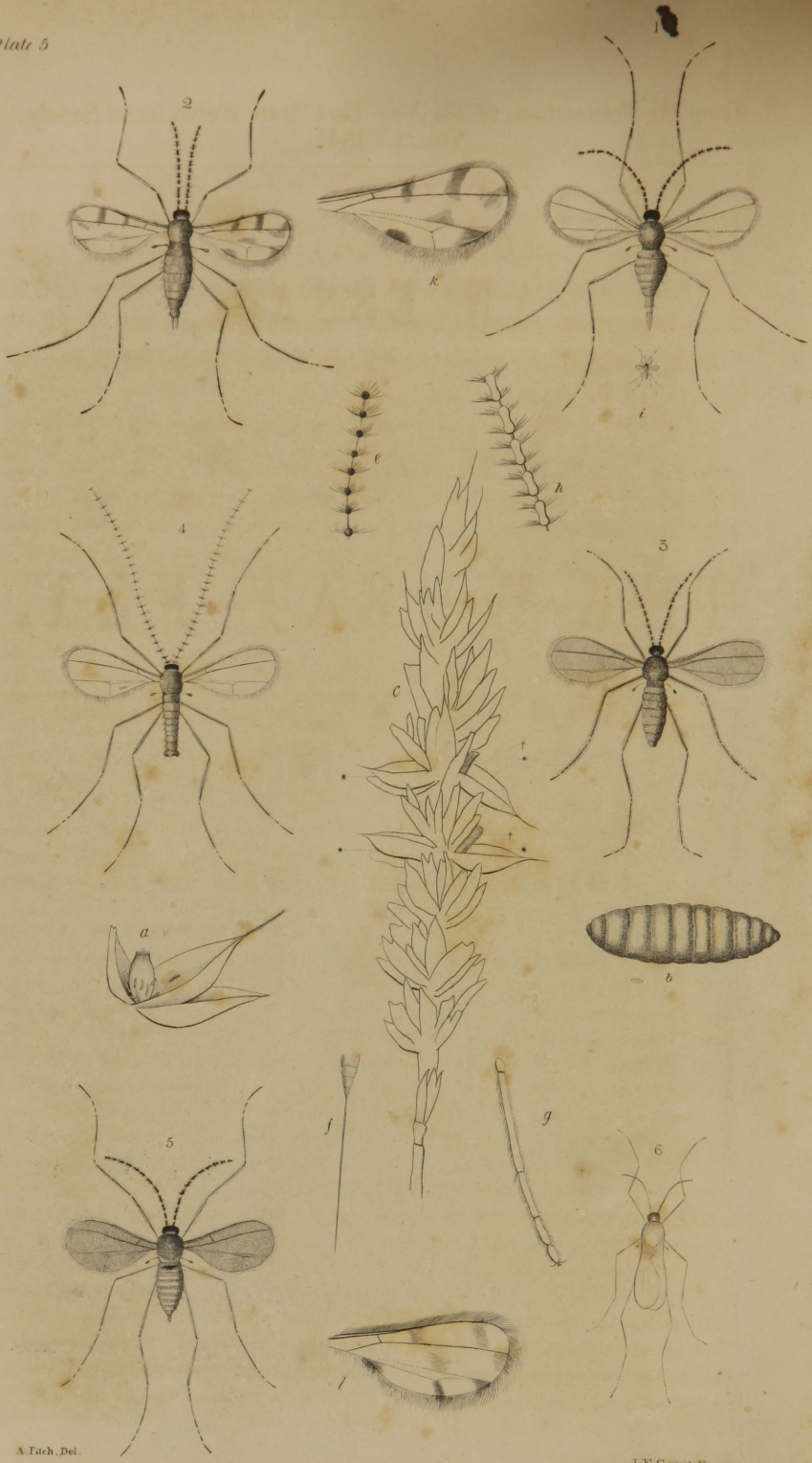
Plate 5



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AN ESSAY

UPON

THE WHEAT-FLY,

AND

SOME SPECIES ALLIED TO IT.

BY ASA FITCH, M. D.

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"THESE SMALL INSECTS ARE THE WHEAT CROP'S GREATEST ENEMY."—*Gullet.*

THE WHEAT-FLY.*

Although several facts in the habits and economy of the wheat-fly had occurred to my notice at sundry times since its appearance in this vicinity, yet as my leisure for studies of this nature was wholly engrossed in other departments of the science of entomology, these facts had been observed in too cursory a manner to be of material value in preparing an account for the public eye. It has not been until the present year, that I have made this and its allied species my particular study. And as some few interesting points still remain undetermined, ere a perfectly complete history of this insect can be given, I should be inclined still to defer preparing a paper upon this subject, but that I deem some of the observations already made of too much importance to be longer withheld, and am moreover very well aware that if no writer ventured to appear before the public until his investigations were so complete in every particular that he could *exhaust* the subject on which he wrote, very little would be published, and the world would have but a small fraction of that amount of information which it now possesses.

It is necessary for me further to premise, that although we have two distinct species of wheat-flies, as will be fully shown in the sequel of this paper, to wit, the *clear-winged wheat-fly* (Cecidomyia Tritici of *Kirby*) and the *spotted-winged wheat-fly*, which has hitherto remained a nondescript; yet as nothing is yet known of the habits and transformations of one of these as distinct from the other, through the body of this article the common name "wheat-fly" will be employed for convenience as referring to both these species. Future researches, however, may detect dissimilarities in their habits, and show that portions of the following account are true only with regard to one of these.

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* The following essay originally appeared in the American Quarterly Journal of Agriculture and Science, vol. ii, number 2; to the editors of which our acknowledgments are also due for the illustration with which it is accompanied. The essay has been revised, and new paragraphs added by the author.

Its Foreign History.

The first distinct and unequivocal account of the wheat-fly, of which I am aware, is that given by Mr. Christopher Gullet, in 1771, in a letter to Dr. Matty "On the effects of elder in preserving growing plants from the insects and flies," which letter was published in the Philosophical Transactions of the Royal Society the following year.*

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* So long ago as the year 1768, Col. Langdon Carter, of Virginia, transmitted to the American Philosophical Society a paper entitled "Observations concerning the FLY-WEEVIL that destroys the wheat;" which was published in the first volume of the Society's Transactions, 2d edition, pages 274–287. The account here given, is in nearly all its particulars so strikingly applicable to the wheat-fly, that so much of it as relates to the insect itself merits an introduction in this place. He rather quaintly remarks, "In a pleasant evening, after the sun was down, and every thing serenely calm, I found the rascals extremely busy amongst my ears, and really very numerous. I immediately inclosed some of them in a light loose handkerchief; and by the magnifiers of my telescope, I took occasion minutely to examine them. They are a pale brownish moth, with little trunks or bodies, some trifle shorter than their wings; and as some of their little bodies appeared bulging as if loaded; I applied the pressure of a fine straw upon them, and saw them squirt out, one after another, a number of little things which I took to be eggs, some more, some less: some emitted fifteen or twenty of them; and others appeared extremely lank in their little trunks, which I could not make discharge anything like an egg. Whether they had done this in the field before, or were of the male kind, I could not tell; but from this discovery I concluded that there need not be above two or three flies to an ear of corn, to lay eggs enough to destroy the greatest crop. * * * It is with much propriety called a weevil, as it destroys the wheat even in our granaries; though it is not of the kind termed by naturalists the *curculio*, of which they have given a very long list; for it is not like a bug; it carries no cases for its wings; neither has it any feelers, with which the curculio is always distinguished; and perhaps (as I fancy it will turn out in the course of this letter that they never attack grain when hard) they really have no occasion for such feelers. For from the make of it, to my judgment, it appears an impossibility that it should ever perforate into a hard grain, being furnished with nothing in nature, from the most minute examination by glasses, that could make such a perforation; and seems indeed a fly itself, consisting of nothing sensible to the slightest touch with the finger, nor to the eye assisted with glasses, leaving only a little dry pale brown glossy dust on being squeezed."

I doubt not but that on perusing this extract, almost every reader who is conversant with our wheat-fly, which also is so frequently called "the weevil," will feel confident that it is the same insect to which Col. Carter alludes. Yet if his account be more particularly observed, we gather from it some characters which assure us that it was not the wheat-fly which he examined. Although he uses the terms *moth* and *fly* as synonymous, and no where tells us whether his specimens had four or only two wings, yet he could scarcely have spoken of the lively orange color of our wheat-fly as "pale brownish;" and what is yet more conclusive, his insect, on being pressed between the fingers, left "a little dry pale brown glossy dust;" whereas the wheat-fly leaves no mark upon the fingers, unless it be actually crushed, in which case its

From this it would appear that the effects produced by the wheat-fly had been known for some time to the farmers of England, though imputed by them to a wrong cause. He says, "What the farmers call the yellows in wheat, and which they consider as a kind of mildew, is in fact occasioned by a small yellow fly with blue wings, about the size of a gnat. This blows in the ear of the corn, and produces a worm, almost invisible to the naked eye; but being seen through a pocket microscope, it appears a large yellow maggot, of the color and gloss of amber, and is so prolific that I last week distinctly counted forty-one living yellow maggots in the husk of one single grain of wheat—a number sufficient to eat up and destroy the corn in a whole ear. * * * One of these yellow flies laid at least eight or ten eggs of an oblong shape on my thumb, only while carrying by the wing across three or four ridges."

It was several years subsequent to this date, that the accounts of the appalling ravages of the Hessian fly among the wheat crops of America reached Europe; and as this fly was universally believed to have been derived from the old world, extensive and careful examinations of the grain fields there were made to detect it, that its habits might be learned, and means devised for preventing its becoming such a scourge as it was to this country. These investigations, conducted often at the public expense, and by men whose acquirements peculiarly fitted them for such a work, resulted in a confident announcement, which received general credence for a long series of years, that the Hessian fly did not exist in Europe; yet in their course, several other species of insects injurious to the cultivated grains of that continent were discovered, and the wheat-fly received a particular examination. Mr. Curtis, generally so accurate in his statements, says that it was first discovered at this time; but the account already given from Mr. Gullet, shows that it was known in England at least twenty-five years earlier than Mr. C. supposes, and

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fluid juices produce a yellow stain, without any glossiness. Every one accustomed to the handling of insects, will at once recognize the character in question as applying admirably to some small species of moth; and the "Committee on Husbandry" of the Society, in their remarks at the close of Col. Carter's paper, are doubtless correct in their statement, that these insects "appear to be of the same kind with those that do the like mischief in Europe, which a gentleman of Angumois describes to Mr. Duhamel," and which have since become so well known as the "Augnmois grain-moth," described by the naturalist Olivier under the technical name of *Alucita cerealella*.

anterior even to the date when the Hessian fly was first observed in America.

In 1795, as we are informed by Mr. Marsham, in a paper read before the Linnæan Society, London, and published in their Transactions, vol. iii. p. 142, towards the end of July, Mr. Long had observed an insect that threatened to do much mischief to the wheat crops, attacking one or more of the grains in an ear, and causing the chaff of these grains to become yellow or ripe, whilst the remainder of the head was still green. Mr. Marsham, on opening the chaff of these grains, found an orange-colored powder, and in many of them one or two very minute yellowish-white or deep yellow larvæ, the grain itself appearing to be a little shrunk. Mr. Markwick, of Sussex, also observed the same larvæ in his wheat, the forepart of August, but was confident they had done no injury to it. The same larvæ were also noticed by Mr. Kirby, this year, in Suffolk.

In a subsequent paper from Mr. Marsham (*Trans. Lin. Soc.* vol. iv. p. 224), we are informed that Mr. Markwick, July 12, 1797, saw the flies themselves, at rest upon the heads of the wheat, and also a few of the larvæ within the flowers ; and that awhile later in the season the fly appeared reduced in numbers, whilst the larvæ had become much more abundant. From heads of the wheat enclosed in a flowerpot, he reared the fly, and also its parasite ; the fly thus obtained having " spotted wings," a fact which we shall revert to hereafter.

Following this account is an excellent article (p. 230) by the Rev. William Kirby, who has since become so well known by his various writings upon entomology. Mr. Kirby here gives a scientific description of the wheat-fly, bestowing upon it the specific name *tritici*, by which it has been definitely distinguished by all subsequent writers, and correctly referring it to the genus *Tipula* of Linnæus, a genus which, in consequence of the vast number of species afterwards discovered to be comprised under it, naturalists have since found it necessary to subdivide ; and the species in question at this day falls within that group to which the name *Cecidomyia* was given by Latreille—an arrangement concurred in by Mr. Kirby himself in his communication in Loudon's Magazine of Natural History, vol. i. p. 227 ; and which I note thus particularly, as by most writers in our

agricultural papers it is still spoken of as solely the *Tipula Tritici* of Mr. Kirby.

In this article, and another presented about a year afterwards, (*Trans. Lin. Soc.* vol. v. p. 96), Mr. Kirby gives a large number of most interesting and valuable observations upon this insect, the correctness of which, generally, more recent investigations have fully attested. With regard to its abundance at that time, he says he could scarcely pass through a wheat field, in which some florets of every ear were not inhabited by the larvæ ; and in a field of fifteen acres, which he carefully examined, he calculated that the havoc done by them would amount to five combs (twenty bushels).

From this time we have met with no notices of the wheat-fly, except occasional references to the articles above mentioned, until the year 1828, when, and for a few of the following years, it again appeared in such numbers and with such havoc in several of the counties of England and Scotland, as to elicit communications in the magazines from several writers. In some districts of Scotland, its devastations would seem to have approached in severity what has been experienced upon this side of the Atlantic ; for "Mr. Gorrie estimates the loss sustained by the farming interest in the Carse of Gowrie (the rich alluvial district along the Isla and its tributaries in Perth and Forfarshire) by the wheat-fly alone, at 20,000*l.* in 1827, at 30,000*l.* in 1828, and at 36,000*l.* in 1829" (*Encyc. of Ag.* 3d Lond. ed. p. 820. § 5066). And Mr. Bell, writing from Perthshire, June 24, 1830, says, "We are anxious to have the present cold weather continue for another ten days, to prevent the eggs from hatching, until the wheat be sufficiently hardened and beyond the state which affords nourishment to the maggot. Another year or two of the wheat-fly will make two-thirds of the farmers here bankrupts," (*Gardener's Magazine*, vol. vi. p. 495). Mr. Gorrie, in a letter dated at Annat Gardens, Errol, Perthshire, Sept. 1828, (*Loudon's Mag. of Nat. Hist.* vol. ii. p. 292), solicits information "on the nature and mode of propagation of a fly which has this year destroyed about one-third of the late sown wheat all over this country." He describes a small yellow caterpillar, one-eighth of an inch long, as numerous in the young ears of wheat, completely devouring the young milky grain, becoming torpid in about twelve days, and in six days more changing to a small black fly. In a subsequent communication, August

1829 (p. 323), he corrects the latter part of the above statement, and says, "At that time I did not know that a yellow fly had deposited the eggs within the glume, which became maggots. Observing numbers of black flies on the ears of wheat, I believed they had been the produce of the caterpillar. I have this season, however, observed the yellow fly (described by Rev. W. Kirby) deposit its eggs in the wheat-ear," etc. I notice this more particularly, because the farmers in this vicinity, with scarcely an exception, have fallen into the same error, and to this day suppose a small black fly, of the family *Muscidæ*, which occurs abundantly in wheat-fields, to be the real wheat-fly.

Mr. Patrick Shirreff, of East-Lothian, gives, in the same volume of Loudon's Magazine, pages 448 – 451, an excellent and very accurate summary of the habits and transformations of the same insect, the result chiefly of his own observations. For a concise account, this is not surpassed by any that has fallen under my notice.

Still more recently, this subject has been investigated by the Rev. J. S. S. Henslow, Prof. of Botany in the University of Cambridge, whose valuable "Report on the diseases of wheat" forms the first article in vol. ii. of the Journal of the Royal Agricultural Society of England. And in the same Journal for the present year (vol. vi. p. 131. plate M.) an admirable production is inserted from the pen and graver of that accomplished naturalist, John Curtis, F. L. S., giving much more accurate and precise descriptions and delineations of the wheat-fly, in the different stages of its existence, than any that had previously appeared. To it I am particularly indebted for such characters as enable me to say without a doubt, that the clear-winged wheat-fly of America is identical with the English *Cecidomyia Tritici*.

In closing this summary of the notices of the wheat-fly abroad, I would allude to what has occurred to me as perhaps true in the history of this insect, to wit, that it has somewhat *regular periods of recurring* in such numbers as to become a pest to the agriculturist. Thus, it is manifest from Mr. Gullet's account that it was abundant for a few years previous to 1771. So destructive was it then, that he pronounces "these small insects—the wheat crop's greatest enemy." After an interval of twenty-five years, it is again observed plentifully for three or four years, and in different districts, by Messrs.

Kirby, Markwick and Long. Again it ceases to elicit attention, until a period but a little longer elapses, when, in 1828 and the following years, it forces itself once more and still more prominently into notice. All that I design, is to direct attention to this point: the facts are as yet too few and too vague to justify anything more than a suggestion. The observations of Mr. Kirby, reaching now over half a century, could probably shed some light upon this most interesting topic.

As respects the *extent of its range abroad*, it has been noticed in most of the southern and eastern counties of England, from Cornwall to Norfolk, and also in Shropshire; in Perthshire and the Lothians, and probably in other districts of Scotland; and in the north of Ireland. Whether it occurs upon the continent of Europe, we are not positively informed. It is not noticed by Macquart, either in his Diptera of the North of France, or his Natural History of Dipterous Insects (for a perusal of which I am indebted to the courtesy of Dr. T. W. Harris of Harvard University;) and we can scarcely believe that if it existed in his district, it could have been overlooked by so assiduous a naturalist. M. Herpin, however (as we are told by Mr. Curtis,) is of opinion that it is an inhabitant of France, and the statement which he makes strongly supports this opinion. He says, "I have also found in ears of corn, at the time of flowering, many little yellow larvæ, very lively, from two to three millimetres long, lodged between the chaff of the grain: these larvæ nibble and destroy the generative organs of the plant, and the germen where they are found are sterile. These larvæ appear to me to have a very great analogy with those which have been described in Linnæan Transactions, under the name of *Tipula Tritici:* it is probably a *Cecidomyia.*" M. Herpin placed several ears of diseased barley and wheat in bottles, and in these bottles a number of Cecidomyia flies were afterwards found. Meigen—a copy of whose noted work upon the Diptera of Europe I regret that I have been unable to meet with—as I learn from Mr. Curtis's paper, gives descriptions and figures of the wheat fly. Were his specimens collected in Germany, or received from England?

It will be unnecessary to particularly specify the various notices of this insect, that have appeared in the different agricultural papers of the Northern States during the last twelve years. The more important and valuable of these may be found in the several volumes of the Cultivator and of the New-England Farmer. An excellent summary of the history and habits of the wheat-fly, both in this country and abroad, is also given in Dr. Harris's Report on the Insects of Massachusetts, p. 437–444. Mr. Gaylord's paper on injurious insects briefly notices this species (*Trans. N. Y. State Agric. Society*, 1843, vol. iii. p. 145–147.)

With the prominent facts that have been laid before the public by our agricultural periodicals, every intelligent farmer is already familiar. The great difficulty experienced by persons but little conversant with zoological science, in determining what this wheat-worm really was, forms a striking feature in the earlier notices that appeared respecting it. Thus, by some it was for a time regarded as an animalcula of the *vibrio* genus, analogous to the "eels" generated in vinegar and paste. By others, and quite extensively, it was pronounced to be a *weevil*, and this very improper name is to this day often applied to it. Others, still, deemed it to be "Monsieur Tonson come again," considering it as a return of the *Hessian fly* to a section of the country from which it had long been absent. It would be easy to point out how erroneous each of these opinions are; but I deem it wholly unnecessary, as the public mind is now no longer distracted upon this subject; and the correct view, that this insect is a fly, peculiar in its habits, and differing from any of those previously known in this country, universally prevails.

It is not improbable but that one or both of the species of the wheat-fly may have been present in this country, in limited numbers, many years before it was distinctly noticed. In truth, common as this insect still is in this district, if our farmers, guided by the knowledge they have acquired of it, were not zealously searching for it in every field, I much doubt whether it would be at all observed here at the present day. And often too when a careful examination of the growing grain leads to a belief that the crop is scarcely infested, an inspection of the threshing-floor, or of the screenings of the fanning-

mill, will frequently demonstrate that it was present in much greater abundance than was surmised. These facts plainly show, that this insect *might* lurk a long time in our country wholly unobserved.

Mr. Jewett says the wheat-fly first appeared in western Vermont in the year 1820, (*New Eng. Farmer*, vol. xix. p. 301.) It was not, however, till the years 1828 and 1829 that it became so numerous as to attract the attention of community ; the same years, be it observed, when its ravages were so annoying in Scotland. It was in the northern part of Vermont, bordering upon the line of Lower Canada, where it became so excessively multiplied at this time ; and from that, as a central point, it seems to have extended in nearly all directions. In this vicinity, one hundred and twenty-five or fifty miles south of the locality above indicated, it was certainly observed in 1830 ; and in 1832 the wheat crops were so completely destroyed by it, as to lead to a general abandonment of the cultivation of this grain. This was the year in which the malignant cholera swept over our land, and it was a common remark, that what the pestilence spared famine bade fair to destroy. Having spread east over Vermont and New-Hampshire, it in 1834 appeared in the State of Maine, and continued to advance in that direction, it is said, at the rate of twenty or thirty miles a year. Westward its progress would seem to have been less rapid, and along the Mohawk river by no means so generally destructive. It is not till within a year or two past, that it has appeared in the Black river country east of Lake Ontario, as I am informed by an intelligent gentleman resident there ; nor until the present season that it has been so injurious as to induce in some instances a premature mowing of the crop, and preserving it for hay. Rumor states that farther west, in the wheat-noted Genesee country, it has been detected for the first time the present year.

The *amount of injury* inflicted by this insect will be more distinctly and vividly realized, if we can arrive at some approximation to the sums of money that have been lost to certain districts in consequence of its presence. The Maine Farmer, vol. xiv. No. 2, states that "a million of dollars, nay, more money, would not pay the damage it has done to the state of Maine, alone." Half of that sum, it is probable, would not repay the loss which has been sustained merely in Washington county, N. Y.—a county embracing (the untilled mountain district bordering upon Lake George being deducted,) a population of about

35,000 souls, and an area of 700 square miles, of which nearly 500 are cleared and improved.

Lest this statement should be deemed extravagant by the reader, I will adduce the data on which it is founded. When it is considered that the entire crop of 1832 was almost totally destroyed—that the crop of the previous year was much injured, and that for several of the subsequent years the man was deemed fortunate who received but half of a fair yield per acre—many obtaining back but little more than the amount of seed which they committed to the ground. I say, when these facts are duly considered, I think it will be regarded as but a moderate estimate if we set down the total amount of loss during the fourteen past years, as equal to the entire crops of three years, under ordinary circumstances. Had the usual quantity of land been all along sowed with wheat, the loss would doubtless have been double that which we here are supposing it to have been. What, then, was the amount of the ordinary wheat crops in this country, formerly? No statistics, that I am aware, were then taken, by which this point can be definitely ascertained. But in 1844—the crop of which year is commonly supposed to have been about a third or a fourth less than what was required for the consumption of the country—according to the census returns, 75,500 bushels were produced.

Now, since the county formerly not only supplied its own wants, but transmitted a considerable surplus annually to market, it is probable that the yearly crop previous to the appearance of the wheat-fly, was twice or thrice what it amounted to in 1844, which would be from 150 to 200,000 bushels, the value of which for three years, gives us the sum first stated, half a million of dollars. And this estimate, be it observed, only contemplates the grain that has been destroyed, without taking into consideration the detriment that has been indirectly sustained by our farmers in being driven to a cultivation of those coarser grains which have yielded them a much less profit.

The adjoining counties of Rensselaer and Saratoga, and the five western counties of Vermont, constituting the district over which this fly first swept and where perhaps its ravages have been most severe, have probably suffered in about an equal degree with Washington county. Together they embrace an area about six times greater than that of Washington county. The whole of this district is therefore about equal in extent to the State of Connecticut, and the amount of

loss from the wheat-fly, upon the data above indicated, may be set down at *three and a half millions of dollars!*

The history of the career of this insect, appears to be quite uniform in most of the districts hitherto visited by it. About two or three years after its first arrival at a particular locality, it becomes most excessively multiplied, and the devastations which it now commits are almost incredible. Though I believe that, through unduly excited fears, or a hope of thereby destroying hosts of this marauder, a mowing of the crop whilst yet green and a curing of it for hay has often been resorted to, when, had it been harvested as usual, a less sacrifice would have been made—yet many cases have occurred in which diligent search by different persons has failed to discover a single developed kernel of grain in any of the heads of an entire field!

This havoc, so extreme and general, though not universal (for some fields even now escape with comparatively little injury,) lasts but a few years. The numbers of the pest and its consequent ravages soon become sensibly diminished ; and after the lapse of some seasons, the cultivation of the wheat crop is again found to be comparatively safe, and its yield only in isolated instances materially lessened by the continued presence of the fly, which has now become probably a permanent inhabitant.

It is now commonly supposed that this rapid diminution in the numbers of the wheat fly has been produced by the general abandonment of the cultivation of wheat in this section of the country ; that thus the insect, having no place to deposit its eggs where its young could be nourished, has become measurably "starved out." But that this opinion is erroneous, is I think evident from one or two facts. During this entire period, since notice was first attracted to the wheat-fly, there are some farmers who have every year continued the cultivation of wheat with very fair success, their crops having been in no one of these years so severely injured as to dishearten them ; and their respective situations are so dissimilar, that this immunity can with no plausibility be attributed to any peculiarity in the location of their farms. Now if the swarms of these insects which for a time pervaded every neighborhood through this entire section of country, and which possess a power of wing capable of bearing them from twenty to fifty miles in a single season, had been in the "starving" condition supposed, how have the fields alluded to escaped destruction? Certainly these myriads of tiny

creatures could not have been reduced to such straits for want of the appropriate repository for their eggs, until after these crops have been utterly consumed. And, with the insect not exterminated, but still everywhere common, now that the culture of wheat has been gradually returned to with such success that it has again become general, why has not the fly again increased? Why have the considerable crops of the past and the abundant ones of the present year (1845) in this county, been so little injured? I am firmly persuaded, therefore, that the speedy diminution in the numbers of the wheat-fly, which soon follows a season in which it has been extremely annoying, can not be truly assigned to the cause above stated; but that it is rather to be attributed to that beautiful provision of nature long since observed, and additional instances of which are brought to light by the investigations of every year, to wit, that an undue increase in any of the species of the animal or vegetable world never takes place, without being speedily succeeded by a corresponding increase of the natural enemies and destroyers of that species, whereby it again becomes reduced to its appropriate bounds.

Whenever once introduced, it is probable the wheat-fly will ever after continue in limited numbers, laying the wheat crop annually under a moderate contribution for its support. Isolated fields will occur where its devastations will be quite serious, whilst the crop of the district generally will suffer but little, and many fields none at all. Such has appeared to be its history in this vicinity for several years past. Seasons favorable for its multiplication will doubtless occur, when its injuries will be much augmented; as well as seasons of a reverse character, when its presence will scarcely be known. It is therefore very important that the entire history and habits of this insect should be accurately traced out. For only with a full knowledge of these, can we be able to resort intelligently to such measures as will keep its numbers constantly limited, or sweep it from those fields that will probably at times be excessively infested by it.

Its habits.

Relying upon the correctness of the published statements, that it was not till "towards the last of June" that the fly infests the wheat-fields, and that the "principal deposit of eggs is made in the first half of July," I had not commenced searching for it, when on the

16th of June I was informed by a neighbor, that it had been present for some days in large numbers, in a field of thrifty winter wheat of his. Upon repairing to this field, a small black fly, about one-third of the size and much resembling the common house-fly, was pointed out as the dreaded enemy; and so universally has this doubtless harmless species been for years regarded as the true wheat fly by the farmers throughout this whole section of the "infected district," merely from the circumstance of its occurring abundantly in wheat fields simultaneously with the wheat-worm, that my companion was much surprised, and disposed to be incredulous of my assertion that *that* was not the wheat-fiy. On opening the flowers of wheat, however, the eggs of the real marauder were found in abundance; and a sweeping, with the small gauze fly-net in common use by entomologists, between the stalks of grain towards their roots, immediately caught within it a number of the winged insects. My comrade was little less surprised on my pointing the real fly out to him, being scarcely able to conceive that such a tiny fragile atom, seemingly a mere moat floating before his eye, could be that potent enemy that had spread such desolation over our land. Several of the specimens thus caught, were of the spotted-winged species. These I conjectured, until I afterwards came to examine them attentively with the microscope, were only a variety of the common or clear-winged species, else I should not have failed to have regarded them more particularly.

All parts of this field of four acres were found to be infested more or less with the wheat-fly, but they occurred most abundantly along one of its sides, in the field adjoining which, wheat had been grown the preceding year, which had been considerably injured by this insect. Such a host of destroyers as were here found, and the profusion of eggs that had been already deposited, strongly indicated that it must have commenced appearing in its winged state many days previous to this time.

The wheat-fly may be met with daily, from the fore part of June, until so late at least as the middle of August. Although it congregates in swarms about fields of wheat at the time they are in blossom, it also occurs in a great variety of other situations. It often enters houses, upon the windows of which it may be observed dancing along the panes, sometimes in numbers. It may also be taken among the grass of pastures, and of alluvial meadows that have never been turned up

by the plow. It is sometimes found in shady places, particularly along the margin of streams, associated with other minute species of *Tipulidæ* in those dances in which swarms of these insects so often engage. One specimen was met with on weeds, in the margin of an entensive and dense forest, through which it must have made its way, or over an adjoining lake a half mile broad, on the opposite side of which was the nearest cultivated ground.

The fly during the sunshine of day moves about but little, remaining mostly at rest or lurking about in the shade furnished towards the roots of the growing grain. In the twilight of evening it becomes active and continues so perhaps during the entire night; for before the morning sunrise it may be seen abundantly upon the wing, though less agile than in the evening, as though it had now become somewhat wearied or was rendered sluggish by the coolness and dampness of the night air. Upon cloudy days, also, it resorts but little to its usual retreats. In short, it appears to be only the direct rays of the sun which it avoids, for if a tree be standing in an infected wheatfield, the fly may be met with in its shade, on the wing and depositing its eggs at mid-day. Hence those parts of a field shaded by trees or an adjoining wood, have been repeatedly observed to be severely devastated or even entirely destroyed, when the other parts of the same field have been but moderately injured.

But it is during the evenings which succeed hot days of sunshine that the fly appears to be most busy and full of life. If a field infested with them be visited with a lantern at this time, such hosts as were little imagined to exist, will be found busily hovering about the grain, the most of them with wings and legs extended, dancing, as it were, slowly up and down along the ears, intently engaged in selecting the most suitable spot where to deposit their eggs. This being found, the insect alights, and standing upon the outer glume or chaff of the kernel, curves its abdomen so as to bring the tip in contact at right angles with the surface of the glume. It now toils industriously to insinuate its ovipositor through the scale, which is not accomplished till after a considerable exertion. Sometimes even, the scales having probably acquired too much maturity and hardness to be pierced by the tiny stinger which the fly protrudes, it is foiled in its efforts, and, as if vexed at its ill success, spitefully jerks its wings apart and darts away. This occurrence, however, is rare. And having penetrated with its

ovipositor into contact with the germ of the future grain, through this tube one egg after another is passed in at short intervals until several are deposited. The usual number of eggs thus deposited, appeared to be from six to ten; and as thrice or four times as many larvæ can sometimes be met with on a single germ, it is probable that three or four insects sometimes successively puncture the same floret. Very frequently two, four or six flies may be seen at the same time on different florets of the same ear, depositing their eggs; and Mr. Shirreff says, "Upon one occasion I numbered thirty-five flies on a single ear, and, after carrying it a distance of a quarter of a mile, six of them still continued to deposit eggs." This work being done, another laborious task for the tiny creature remains, that of withdrawing the ovipositor; and to accomplish this, the energies of the insect are sometimes inadequate, and it remains, Prometheus-like, chained to an immoveable mountain, until it expires. This curious fact, first observed by Mr. Kirby, I have seen fully verified, meeting in several instances with the dead insect still remaining thus suspended.

Although the flowers of the wheat are the favorite resort of this insect for depositing its eggs, yet it is not limited solely to this plant. It is currently reported to have been occasionally met with in rye and oats in this country. Mr. Shirreff and Mr. Gorrie both found the wheat-worm in ears of the quack or couch grass (*Triticum repens* Linn. ; *Agropyron repens*, Pal. de Beauvois); and the latter gentleman hereupon rather naively remarks, "The fly has not known that modern botanists no longer ranged the couch grass among the wheat tribe ; but, like myself, it is most attached to the Linnæan names and systems." Mr. Markwick also found the same worms in the wild bearded oats (*Avena festuca*, Linn.)

The *eggs* are of an oblong, cylindrical form, with rounded ends, They are pellucid and nearly colorless at first, but acquire a yellowish tinge ere they are hatched, which is in rather over a week after they are deposited.

The *larva* has two distinct stages in its existence : an *active* or growing state, which is passed through in about a month ; and a *dormant* state, which then supervenes, and continues through the winter. This latter has been generally but incorrectly regarded as its pupa state by writers.

When it comes from the egg, the larva is a minute oblong soft

worm, without feet or hairs, and transparent or of a whitish tinge at first, but soon changing to a bright amber or orange yellow. It moves but slowly, and with difficulty, by a wriggling motion of its body. It remains within the particular floret in which it is hatched, until it attains its full growth. Mr. Kirby says it feeds upon the pollen of the anthers; and perhaps it does so at first, but certainly whilst they are quite small, all the worms within the floret cluster upon the sides of the germ, and generally towards its base (Plate 5, fig. *a*.) I apprehend they chiefly subsist and attain their growth there, upon the fluids destined for the nourishment of the germ, and which, for want of these fluids, becomes shrivelled to a greater or less degree, and does not attain that plump form on which the value of this grain so much depends. The amount of injury received by the individual kernel of grain varies according to the number of worms that have been nourished in the chaff in contact with it. If mature worms grow from all the eggs deposited by the fly at a single puncture, the kernel is doubtless rendered worthless; but a single worm, as is occasionly found, would scarcely produce a perceptible effect.

Having attained its growth, and in its dormant state, it does not differ sensibly, as I have been able to discover, from its previous appearance; and the only reason for marking this as a distinct stage, is, that the insect now remains for a long period (probably two-thirds of its entire term of existence) without increasing in size or undergoing any other perceptible change. The texture of its body seems to have acquired rather more firmness than it possessed while it was growing, and its motions are more sluggish. It is less than the tenth of an inch long: a measurement of several specimens gives 0.07 as their average length. It is of a rich orange color, and of an oblong-oval form (Plate 5, fig. *b*), being broadest in the middle and rounded at each end: it is slightly depressed, the under side being considerably flattened; thus in form somewhat resembling the leech when contracted. Its joints are indicated by slight transverse impressed lines, by which it is divided into twelve segments of about equal length. Sometimes a brownish cloud is perceptible near the middle of the body on its underside, which is probably caused by alimentary matter. If these worms are placed for some days on a plate in a dry room, the outer skin of the body becomes so dry and

indurated that the worm is incapable of making the slightest motion; but on covering them with a wetted cloth, the surface again in a short time becomes pliant and yielding; and if pressed with a needle, the animal writhes, and sometimes turns itself over to escape from the annoyance. I doubt whether it ever moults, or casts off its skin, between its egg and its pupa state; but my observations have not been sufficiently exact and prolonged to speak positively upon this point.

This is the form in which the insect passes the autumn and winter. The accounts of writers disagree as to where the worm remains during this period; in fact few of them speak distinctly upon this particular point. Mr. Kirby, however, describes the worm as still continuing in the heads of the wheat; but as a considerable portion of them are missing, he thinks these have been destroyed by parasitic enemies. He says, "I have seen more than once, seven or eight florets in an ear inhabited by the [active] larvæ, and as many as thirty in a single floret, seldom less than eight or nine, and yet I have scarcely found more than one pupa [dormant larva] in an ear, and had to examine several to meet with that." Mr. Gorrie, on the other hand, asserts that the maggots quit the ears of the wheat by the first of August, and enter into the ground, where they remain through the winter. Mr. Shirreff, also, from finding the fly much more abundant in fields where wheat had been grown the preceding year than it was in other fields, entertains the same opinion. Now the truth is, Mr. Kirby and Mr. Gorrie are both right. A portion of the larvæ leave the grain before it is harvested, and descend to the ground, where I have found them, under mouldy fragments of straw on the surface, or buried a half inch or less within the soil. I thus found them, common in the field already spoken of as examined on the 16th of June, a few days after the grain was harvested; and also early in March, in a field in which wheat was grown the preceding year, that had been somewhat injured by the fly. Another portion of these larvæ remain in the heads of the wheat, and are carried into the barn, where they may readily be observed upon the threshing-floor, and found in quantities among the screenings of the fanning-mill, a considerable portion of which sometimes consists of these worms. Thence our farmers *kindly* empty them out at the door of the barn, where most of them doubtless find among the litter

of the yard a bed equally as comfortable and secure as that in which their brethren in the field are at this time reposing.

Whence does this singular diversity in the habits of these larvæ arise ? All the worms are undoubtedly fully matured before the grain becomes ripe and dry and hard. Why then do one part of them leave the wheat heads and enter the ground ere the harvest—and another portion of them remain within the ears to be carried into the barn with the grain when it is housed ? Two well attested observations, I think, shed important light upon this interesting point. And if the inference which I deduce from them be correct, we have arrived at another very curious trait in the economy of this insect.

Dr. Harris informs us, that " after a shower of rain, they [the larvæ] have been seen in such countless numbers *on the beards of the wheat*, as to give *a yellow color to the whole field ;* " and he refers to the New-England Farmer, vol. xii. p. 60, in confirmation of this statement, a volume which I have not at hand. For an analogous but still more instructive fact, I am indebted to Gen. M'Naughton, a practical farmer of this town, the accuracy of whose statements no one acquainted with him will doubt. In 1832, his wheat, in which the fly had made sad havoc, was cradled and lying in the swath, when a moderate rain came on, followed by a damp cloudy afternoon. At this time, with his hired help, he repaired to the harvest-field to bind up the grain. They here found not only the heads, but also *the straw in its entire length sprinkled over with these worms.* On my observing to him, that I could scarcely believe it possible for a footless worm to crawl along the straw when it was lying horizontally, he stated that he was particularly positive with regard to that fact ; for he distinctly recollected that it was impossible for him to draw the band around a bundle and tie it [in which process the heads of the grain are not touched,] without having at least a half dozen of these worms adhering to his hands.

From these facts, I infer that the worm does not crawl out of the chaff and " drop " itself to the ground, as has been stated by some writers ; but that having attained its growth, it lies dormant within the chaff, awaiting a favorable state of the weather in which to make its descent, to wit, a rain which is not immediately followed by a clear sky and warm sun that would soon dry the straw. Hence it is doubtless almost invariably by night that this journey of the worm

is performed, and that it has therefore never been seen. The straw itself being wet, and the body of the worm rendered supple by the moisture surrounding it, it leaves its abode in the head of the wheat, and adhering to the wet straw by the glutinousness of the surface of its body, gradually works its way downwards by the wriggling motion to which it so often resorts when disturbed, until it reaches the ground. That there is such a glutinous secretion upon the surface of the worm as would enable it to adhere to the wet straw in the manner supposed, I might adduce a number of facts to prove. I was desirous of taking a drawing of the larvæ which I found among wheat-stubble last March ; but particles of earth adhered to them so firmly, that I could not separate them with the point of a needle without also mutilating the worms. A few weeks since, on visiting a neighbor's threshing-floor, I gathered a number of larvæ by moistening the end of my finger and touching it to the worm, which, thus adhering, was scraped off upon the edge of a tin box. The box is now before me, with each of the worms alive, but firmly glued to its sides, and many of them to each other ; and on forcibly removing some of them, the outer dried and hardened case of the worm is fractured in the operation.

It would thus appear that those worms which are matured, leave the grain at the close of a shower, and crawl down the wet straw to the earth. It may be also, that a heavy night-dew sometimes furnishes a sufficient degree of moisture to enable them to do this. But on the other hand, those worms which are later in arriving at maturity, in awaiting suitable weather for making the same descent are, ere such weather arrives, carried with the grain into the barn.

As illustrating the strong tenacity of life possessed by these larvæ, I may in this connexion state, that the few specimens gathered in March as already stated, were placed with a little earth in a vial, and a piece of gauze tied over its mouth, for the purpose of ascertaining the transformations of the insect, if any, from its then condition to that of a winged fly. Other avocations diverted my attention, and this vial was forgotten for a fortnight ; by which time the earth within had become so completely dried, that not doubting but the worms had all perished, no farther attention was paid to it, and it remained in a dry room over three months, until the middle of June, when, on examining it, half the specimens put into the vial were found to have

completed their transformations ; a corresponding number of dead wheat-flies being found attached to a straw in the upper part of the vial. Prof. Henslow thinks that it is only those larvæ that are punctured by ichneumons, that leave the wheat-ears and enter the ground ; but the facts now stated show that this opinion is erroneous.

On removing the earth from the vial above alluded to, the cases of the *pupæ* from which the flies had proceeded, were found very perfect. These conclusively showed that the real pupa is not formed until in the spring, and that it is then altogether different in form from what has been described by writers as its pupa. It corresponds identically in its appearance (perhaps with the exception of color) with that of the *Cecidomyia Salicis*, as exhibited in the first volume of the American Quarterly Journal of Agriculture and Science. Plate 2, fig. 1. It also closely resembles the figure of the pupa of *Cecidomyia Pini ?* as given from De Geer in Westwood's Introduction to the Modern Classification of Insects, vol. ii. p. 518, fig. 125, No. 7.* Its length is slightly less than that of the dormant larva. The antennæ, legs and wings, are each enclosed in separate sheaths, which lie externally to the integument in which the body is enveloped. The three pairs of legs all lie parallel and in contact with each other upon the breast, reaching far down past the tips of the wings ; the inner pair being shortest, and the outer pair longest. Judging from the analogy afforded by the *Cecidomyia Salicis*, I presume the wheat-fly only remains in its pupa state three or four weeks in the latter part of May and the fore part of June.

ITS NATURAL ENEMIES.

One of the most effective natural destroyers of the wheat-fly, is undoubtedly our common yellow-bird (*Fringilla tristis*, Lin.) Fields much infested by the insect, have been for many years recognized even by passers on the highway contiguous to them, by the rough and ragged aspect of the heads of the grain (Plate, fig. *c*). I am not aware that the cause of this peculiar appearance has ever been stated in any of the communications that have appeared in our agricultu-

* I cannot but regard the figure here referred to as inaccurate, in representing the wings as enclosed in one common case, *over which* the legs are laid. The tips of the wings should probably be rounded, instead of being brought to a point.

ral papers. It results from the operations of this bird. Alighting, it adroitly grasps the wheat stalk just below the ear, and clinging fearlessly to it, even when swayed to and fro by the wind, it with its bill parts down the chaff from the grain, and one after another of the worms to which it thus gains access are rapidly picked off and devoured. Thus several heads are generally freed from the worms, ere its repast is completed. That it is the worms and not the grain that it is in pursuit of, is readily ascertained by an inspection of the heads after the bird has left them : many of the kernels, not being sufficiently loosened to drop to the ground by the operation, will be found remaining, the maggots that were upon them only having been removed ; whilst those kernels of the head which are not infested by the worm, are passed over untouched. It is curious that this little creature, by a tap with its horny bill, or some other process, is enabled to distinguish those scales of chaff which conceal so minute a worm, from those which do not ; a knowledge which we only arrive at when we have parted down the chaff. A flock, numbering about fifty, embracing both male and female birds, appeared to make the field which I examined on the 16th of June their constant resort, for a period of three weeks or more, where they could be seen busily occupied almost constantly every day. The number of worms consumed by them during this time must have been immense ; and I cannot but believe that this lovely bird will henceforward be esteemed for its utility, as much as it has heretofore been for its beauty.

I have as yet found but one insect parasite, which I am well assured subsists upon and destroys the worm of the wheat-fly. It is a hymenopter of the family *Chalcididæ ;* but my acquaintance with the details of its history is as yet too limited to attempt an account of it. I shall be much disappointed if I do not meet with still other species which prey upon the wheat-fly ; and as all these parasites upon the Cecidomyiæ are more or less closely related to each other, they can probably be most advantageously presented in a separate article devoted exclusively to that subject.

Four or more species are known abroad, which destroy the wheat-worm. One of these, it is stated in the first volume of the Edinburgh Quarterly Journal of Agriculture, deposits an egg beside an egg of the wheat-fly, the worm from which devours the wheat-worm soon after it hatches, and thus effectually saves the wheat. The observations of

Mr. Shirreff upon another of these cannot but interest the reader. He says, "Upon presenting four larvæ (of the wheat-fly) to an ichneumon, it soon stung, or, according to Mr. Kirby, deposited an egg in each of their bodies, and stung one of them a second time. The maggot writhed in seeming agony, and straggled upon my thumb-nail, where it was again stung three times by the same fly; and in a second struggle, both fell to the ground."

ARTIFICIAL MEANS FOR ARRESTING ITS RAVAGES.

These may be divided into two classes, as they refer to the protection of the grain from the fly when in its winged form and depositing its eggs; or as they directed to the destruction of the fly itself, in the previous stages of its existence.

Several measures have been proposed, and some of them with much confidence and plausibility of reasoning, for protecting the wheat crop from this insect during the period of its blossoming. The more prominent of these I will advert to.

The smoke of a number of smouldering fires, or of brimstone matches, in different parts, and particularly upon the windward side of an infested field, has been recommended. The known efficacy of smoke in repelling the musketoe renders it probable that this remedy would be of signal utility, were it not for the discouraging amount of labor that is required to make so thorough and protracted a use of it as would be necessary.

It has been suggested that the anal follicles of the skunk (*Mephitis americana*, Desm.) might be extracted, and that yarn impregnated with the fluid contained in them, and suspended through wheat-fields, would, by its intolerable odor, banish the wheat-fly. I imagine that in carrying this suggestion into practice, the operator would be *the greatest sufferer*—"unless *my nose* deceives me."

Sowing the field with lime at the time the wheat is in blossom, has been repeatedly, and by some with much confidence, urged. This remedy has been much resorted to, and very conflicting statements with regard to its efficacy have been laid before the public. A simple experiment, directly to the point, is of more value than a thousand cases that *tend to support* any particular opinion; and such an experiment I am prepared to narrate. Jarvis Martin, Esq., the owner of the infested field repeatedly alluded to, at my suggestion, repaired to it one

evening, and sprinkled several of the heads with tolerably fresh air-slaked lime, until they were white with the powder adhering to them; thus applying it far more profusely and effectually than can be accomplished by any "sowing" of this substance. With the light of a lantern, these heads were now closely watched, and the flies were observed to hover around and alight upon them as freely, and insert their ovipositors with the same readiness that they did upon the contiguous heads that were not thus treated. I deem this experiment sufficient to put to rest the much mooted question with regard to the utility of lime as a shield against the wheat-fly.

A yet more prominent, and much more plausible mode of enabling the wheat to escape injury from the fly, is, sowing the seed at such times as will prevent its being in blossom at the period when the insect appears. With this view, it is recommended to sow winter wheat much earlier than was ordinarily done, that it may be so far matured the following season at the time of the appearance of the fly, as to be invulnerable to it; and spring wheat, so late as not to be in blossom until the fly has finished depositing its eggs. This plan has been much relied upon, on both sides of the Atlantic, and I have been heretofore disposed to regard it as probably the most feasible of any—though by avoiding Scylla we are in danger of Charybdis—for early sown winter wheat invites a return of the Hessian fly, and late sown spring wheat is almost certain in this vicinity to be attacked by "the rust" (*Puccinia graminis*). Numerous instances, moreover, can be adduced which tend much to support the utility of this measure. One of these, as strong as any that has come to my knowledge, I may here state. In a field of spring wheat of my own, raised in 1843, every kernel in the top of almost every head was entirely destroyed, whilst the lower two-thirds or three-fourths of the ears were wholly uninjured. I could account for this only by supposing that these heads were just beginning to be protruded from their sheaths as the operations of the fly were closing for that year; and hence confidently inferred that if that wheat had been sowed a few days later, it would have escaped entirely, or a few days earlier, it would have been entirely destroyed. By a reference to my Farm Book, I find this crop was sowed April 26th, and cradled August 10th, but no note was taken of the time when it was in blossom. I must confess, however, that my observations the present season have greatly diminished my confidence in the time of

sowing as securing the crop from injury. Though I did not see the fly abroad until the 16th of June, it was then present in such swarms, and had already deposited its eggs so profusely, that I think it must have commenced appearing quite early in that month. It, moreover, continued to be abundant until about the middle of July, and specimens were occasionally met with a month longer. Certainly if it is usual for it to be spread out over such an extent of time, it will be vain to rely upon the time of sowing to insure a crop against its ravages. Some observations in the foreign accounts also throw light upon this subject. Mr. Shirreff says, in 1829 the fly appeared June 21st; "and from the vast numbers of them then seen, it is probable a few of them may have been in existence some days previous." Their eggs were seen June 23d, and must therefore have been deposited on the evening of the 22d. "The flies were observed depositing eggs on the 28th, and finally disappeared on the 30th of July, thus having existed through a period of thirty-nine days," and depositing eggs during thirty-seven of these days. I know not how Mr. S. could be certain that the fly had disappeared for the season on the 30th of July, for his account is dated the first day of August. For a few days only after their first appearance, he tells us, they frequented the couch-grass as well as the wheat. Was not this because there was not at that time a sufficient quantity of wheat in bloom to accommodate the number of insects that were then out? And Mr. Markwick distinctly states that it was after the grain had been harvested, that he found the larvæ in the wild oats. Were not the parent flies then obliged to resort to this plant, because all the wheat had become mature ere they had completed depositing their eggs? These facts certainly make it appear as though the fly is often abroad before the wheat commences blossoming, and continues till after it becomes mature.

Is there then, no mode by which the flowering grain can be shielded from the ravages of the fly? This is a subject on which I have bestowed much thought; and I am not now prepared to tell the reader what *he must do*, but I will briefly inform him what *I shall do*, upon the first occasion that calls for it. A method is sometimes resorted to abroad, for saving grain fields from the depredations of certain insects of peculiar habits. A rope is drawn along over the grain by two men walking at a brisk pace; which rope thus knocking against the heads of the grain, causes the depredators to drop

themselves instantly on the ground, and it is a slow and tedious task for them to get up to the heads of the grain again. A similar process, but with a different apparatus, I contemplate employing against the wheat-fly. This apparatus is a light net made of gauze, three or four feet deep and one or two rods long; its mouth reaching the entire length of the net, and opening to a width of about eighteen inches. A small rope is to be stitched to the upper and another to the lower side of the mouth, reaching slightly beyond the net at each end, which is to be carried by two persons holding the ends of these ropes. If on closely examining the wheat-fields of my vicinity, from the time that the heads begin to protrude from their sheaths, the fly is found to be gathering in swarms in any one of them, I intend repairing to that field in the evening, when the insects will be hovering in such myriads about the heads of the grain, and, with an assistant, carrying the net so that the lower cord will strike a few inches below the heads of grain, the upper one being held nearly a foot in advance of it, and about the same distance above the tops of the heads, by keeping the cords tense and walking at a uniformly rapid pace from side to side of the field, until the whole is swept over, I shall be much disappointed if *countless millions* are not gathered into the net, which is to be instantly closed whenever a pause is made, by bringing the cords together. It is now to be folded or rolled together into a smaller compass, and then pressed by the hands or otherwise so as to crush the vermin contained within it. This measure has been suggested to me, by observing the perfect facility with which the small entomological fly-net becomes *filled* with these flies, on sweeping it to and fro a few times among the heads of infested wheat in the evening. Of course this operation should be resorted to on the first appearance of the fly in numbers, and before its eggs have been deposited so profusely as will occur in the course of a few days. I feel strongly confident, that by sweeping over a field a very few times in the manner above described, the fly may be so completely thinned out and destroyed, as to be incapable of injuring the crop perceptibly.

With regard to destroying the fly in the earlier stages of its existence, only a few words will require to be said. Whoever has read the preceding account of the habits of this insect, must have been struck with a consciousness of the perfect facility with which that

portion of the worms that are brought into our barns may be exterminated. It would seem as though Divine Providence had expressly designed to place a part of every generation of these insects directly in the hands of man, that he might destroy them or not, at his option. And Uncle Toby is so extremely benevolent, that he has uniformly carried them to the door, and said "Go away, little flies, go away; the world is wide enough for you and me both." Now it is scarcely necessary for me to say, that the screenings of the fanning-mill should invariably be closely examined, and if the minute yellow wheat worms are numerous in them, the person should consider it a sacred duty which he owes to himself and his neighbors, to consign these screenings at once to the flames. If there are but occasional worms among them, let them be emptied into a hog-trough; but never empty them upon the ground, or among the straw of the barn-yard, unless they appear to be entirely free from these vermin. And now, if that portion of the worms which remain in the fields can also be destroyed, it becomes certain that we are at once and forever relieved from all farther solicitude with regard to future injuries which this insect can inflict upon us. But can this be done? It has been proposed to burn the stubble of wheat-fields after the harvest; and if this measure be resorted to at a very dry time in the autumn, probably some of the worms would be destroyed by it. But, so far as I have observed, they uniformly lie here in situations where they are surrounded with some degree of moisture, under damp and mouldy clusters of straw and stubble, or slightly within the surface of the ground. It would, therefore, only be those straggling individuals that were not in their usual haunts, that the transient heat caused by such a burning would reach. Would a turning over of the field with the plow bury them to such a depth, that they would fail of finding their way to the surface again? This is an important inquiry. It is very probable that the larva can work its way to the surface, from a greater depth than what the pupa can. Direct experiment only can determine accurately at what depth the insect, in both these stages, must be buried in order to destroy it. No information of any value can, therefore, be given upon this point, until such experiments are made.

DESCRIPTION OF THE CLEAR-WINGED WHEAT-FLY.

CECIDOMYIA TRITICI.—*Kirby.*

The importance of full and accurate descriptions of every one of the several parts of a natural object, in order that it may be identified with certainty, is strikingly illustrated in the present species. For some years it has been *supposed* to be identical with the English wheat-fly; but those who are aware of the large number of both plants and animals in Europe, that have analogous representatives in this country so closely resembling them as to have been in many instances for a long time considered identical even by accurate and experienced observers, could not but entertain doubts upon this point; and with the fifteen or twenty characters of this insect which could be gathered from different sources, I could still only say that our wheat-fly was *probably* the *Tritici* of Mr. Kirby, some of its prominent peculiarities seeming even to conflict with the descriptions given of that species. For instance, all that we could gather respecting the form of the joints of the antennæ, was, that they were "*moniliform;*" and Messrs. Kirby and Spence, in their "Introduction to Entomology," define this term to mean "oval or globular joints, like a necklace of beads." Now the joints of the antennæ in our insect are oblong, and each has a marked contraction in its middle, thus approaching to an hourglass shape, a form the very reverse of "oval" or "globular." It was not until I saw the excellent figures and descriptions of Mr. Curtis, that I became well assured that our species was identical with the European.

The common reader will get the most clear and definite idea of the appearance of the wheat-fly, by being told that it looks almost exactly like the wheat-worm with wings and legs added to it. These members, however, are so very small as to be scarcely recognized by the naked eyes, except when they are fixed intently upon the object.

The HEAD of the *female* Cecidomyia Tritici (Plate, fig. 1) is of an orbiculate or flattened-globular form, with the *eyes* forming its periphery. These are large, occupying full two-thirds of the entire head. They are of a deep black color, and are separated from each other on the top of the head only by a slight and almost imperceptible cleft, so that when viewed in front they appear like a continuous broad

black band surrounding the head, and interrrupted only below at the mouth, thus resembling a horse shoe in their figure. The *face* is pale yellow. In its centre, and contiguous to each other, are two pale yellow tubercles or spherical eminences, more or less conspicuous, on which the antennæ are inserted, and which are by some regarded as forming a joint of these organs, in addition to the number commonly stated. The *antennæ* are of a deep brown or black color, less intense than the eyes. They are of about the same length as the body, and composed of twelve joints. Each joint (Plate, fig. *h*) is commonly oblong, with a marked contraction in its middle, a shape which is sometimes designated as "coarctiform," and is surrounded with a whirl or row of hairs near its base, and another near its apex.* The joints are ordinarily about thrice as long as they are broad, their diameter being but little less than that of the legs. They are connected together by a slender thread intervening between each joint, and about a fourth as long as the joints themselves. The two *palpi* are pale yellow, and clothed with shortish hairs: each is composed of four oval joints; the one terminal being longer, but of the same diameter with the preceding.

The THORAX is of a pale yellow color; its upper side commonly tinged with fulvous brown, which sometimes, though rarely, forms three vittæ or longitudinal spots forward to the middle. It is of an ovate form, its greatest breadth being immediately back of the wing sockets. Its vertical diameter much exceeds the transverse, as is common in most species of *Tipulidæ*, the breast jutting down far below the level of the head and abdomen. The *poisers* are oval, honey-yellow, their pedicels with a strong notch in the middle of their anterior sides.

The ABDOMEN throughout is of an orange color, more inclining to red than to yellow. Its broadest part scarcely equals the thorax in

*Not unfrequently, however, singular anomalies occur in these joints. Thus in some the contraction will be so considerable as to cause the segment to appear like two globular joints slightly but distinctly separate from each other; whilst other segments *of the same series* are abbreviated and dilated, the usual contraction thus becoming obsolete, and the joint taking on a short cylindrical form. It would thus seem as though we, in the female, met with twenty-four joints of the male attennæ in a modified or imperfectly developed condition; that what appears as a single oblong coarctiform joint, is in reality two joints united. This would give but a single whirl of hairs to each joint, as is common in most of the species of this genus.

diameter. It is of an ovate form, often conspicuously attenuated towards its tip, (as represented, fig. 1.) whence the two valvular sheaths of the ovipositor are seen more or less exserted, and sometimes the apex of the ovipositor itself projecting between them like a fine slender thread. According to Mr. Curtis, by a slight pressure on the abdomen of the living insect, the ovipositor (Plate fig. *f*) can be made to protrude, and may then be drawn out to nearly thrice the length of the body.

The WINGS are hyaline and colorless, appearing like thin plates of glass or mica, but reflecting the tints of the rainbow, particularly the violet, when viewed in certain directions. Their margins are densely ciliated with longish hairs, and their surface is covered with minute pubescence. The mediastinal or *submarginal nerve* is but slightly distant from the costal (marginal), and becomes confluent with it rather forward of the middle of the exterior margin. From its middle, it sends a small connecting nerve backward to the postcostal. The *postcostal*, which is the most conspicuous nervure of the wing, runs direct, or with but an insensible curve, to the tip of the wing. The *medial* is straight, and attains the inner margin at about three-fourths of the distance from the base to the apex of the wing. The *anal* runs nearly parallel with the inner margin, and, with a very sudden curve from its direct course, joins the margin near its middle. It gives off an obscure branch at its angle, which curves outwards and backwards, joining the medial, or rather, seeming (if the wing be moved so as to give a slightly different incidence to the light) to be continued onward, parallel with and contiguous to the medial nerve, till it attains the margin of the wing. The medial and anal nerves are very slender, and are often invisible, except in a particular reflection of the light. The former, especially, can seldom be distinctly traced, except towards its termination. These details of the neuration of the wing apply equally well to all the species of Cecidomyia that have fallen under my observation, save only that they are more distinctly traced in the others, particularly the larger species. At rest (Plate fig. 6,) the wings are laid one upon the other, reposing horizontally upon the back of the abdomen, and reaching about a fourth of their length beyond it.

The LEGS are whitish or very pale yellow, long and slender, of a cylindrical form, and of nearly the same diameter through their entire

length. The coxæ (small joints by which the femurs are connected with the sternum), as they are directed more or less backwards, vary the point from which the legs seem to arise in different specimens when viewed from above. The femurs, tibiæ, and second joint of the tarsi, are all of about the same length. The third, fourth, and fifth joints of the tarsi (Plate fig. *g*), are successively shorter; whilst the basal joint is the shortest of all, its length little exceeding its diameter.

All parts of the body and limbs are clothed with minute, slender, longish hairs.

The MALE differs so remarkably in its aspect from the female, and is moreover so rare an insect, that it has generally escaped the researches of observers. It would appear from Mr. Curtis's paper, that Meigen is the only one who has identified and given a description of this sex; and I should distrust my having any specimens of it, but that one of the flies hatched from the larvæ already spoken of as gathered in a wheat-field early in the spring, is a male (Plate, fig. 4); and a few of my other specimens manifestly coincide with this. In these the *antennæ* are at least double the length of the body, and composed of twenty-four joints of a very exact globular form (Plate, fig. *e.*); each joint encircled with a single row of hairs, and separated widely from its fellows, the thread between being of about twice the length of the joint itself. The *abdomen*, instead of being an ovate form, as in the female, is broadest at the base, and thence tapers gradually, though slightly, towards the apex; the terminal segment, however, being broader than the one or two preceding it, and of a reniform shape, with the lobes directed backwards. The male is also somewhat smaller in size: in all its other marks, it appears to correspond with the female.

Among the hosts of specimens of the female that may be met with, there will occur considerable variations in size, color, and some minor particulars. The common length, to the tip of the abdomen, is the twelfth of an inch, or slightly under this; yet I have measured recent specimens from the wheat-field, that were but half this size. The color seems to be more uniform in specimens taken from the wheat-field, than in those procured in other situations. It is of a lively orange-red, particularly upon the abdomen, where the color is most observed; but varies from that to amber or honey-yellow, lemon-yellow, and even to a cream-color. The specimens already spoken of as having

been raised in dried earth; are all quite pale; and it would hence appear as though these lighter colored varieties were caused by unfavorable circumstances in which the insect had been placed when in its larva state.

THE SPOTTED WINGED WHEAT-FLY.

CECIDOMYIA CEREALIS.

Another species of *Cecidomyia* (Plate fig. 2,) as the reader has been already informed, is frequently met with, associated with the *Tritici* in fields of wheat. It is closely allied to the latter in form and coloring, having like it an orange colored body, hyaline wings, pale yellowish-white legs, and twelve joints to the antennæ, identical with those of the *Tritici* in their details. It is, however, readily distinguished from the *Tritici*, as well as from all the other species of this genus, with only two or three exceptions, by having spots upon its wings. (Plate, fig. *k*.) These spots are so conspicuous as to be recognized by the naked eye, even when the insect is flying. They are of a pale black or smoky color, and six in number on each wing. Two, and these the most conspicuous from being commonly of a deeper tint, are placed upon the outer margin; one being at the tip of the submarginal nerve, where it unites with the costal; the other, half way between this and the apex of the wing. Both these spots reach across the costal cell, and often slightly into the externo-medial. Another spot occupies the apex of the wing, at the tip of the post-costal nerve. Two others are based upon the inner margin, one at the apex of the middle nerve and mostly in the inner middle cell, the other occupying the middle of the anal cell, but nowhere touching the anal nerve. The sixth spot is upon the disk of the wing, mostly in the outer middle cell, and is sometimes confluent more or less with one or more of the marginal spots. The nerves, when traversing these spots, are of a deeper black color than in other parts of their course, as are also the hairs which proceed from them into the fringed border of the wing. These spots are formed by a pigment in the membrane of the wing, the fine pubescence upon the surface being no more dense here than upon the other parts. The species under consideration is farther distinguished from the *Tritici*, by invariably having the base of the abdomen, on its upper side, of a brown or blackish color. The last joints of the

feet, moreover, are black in this species, and there is a broad black band at the base of the anterior tarsi.

The *males* have the antennæ composed of twenty-four joints, each encircled as usual with a row of hairs. These joints approach a globular form, but have, in common with those of the males of several other of our species, this striking peculiarity, namely, that through the whole series, though preserving the same diameter, they are alternately shorter and longer; twelve being compressed-globular or double-convex, and between each of these a very short cylindrical joint with convex ends.

This species is closely related to the *ornata* of Say (*Appendix to Long's Expedition*, p. 357), but is readily distinguished from that by its blackish antennæ, the color of which contrasts strongly with that of the legs; by the greater number of spots on its wings, and these spots not being "occasioned by the greater density of the hair of the surface in those parts." In the latter character it also differs from the *pictipennis* of Meigen, as described by Macquart; as also in not having the spots forming bands across the wings. If any description of the *maculipennis* of Stephens, in his catalogue of British insects, has ever been published, I have not met with it. That this species, however, exists abroad, is highly probable, from the fact that the specimens reared from wheat-worms by Mr. Markwick had "spotted and transparent wings," as he describes them, or "obsolete clouds" as they were termed by Mr. Marsham. Mr. Curtis calls attention to this fact respecting these specimens, apparently from a suspicion thus excited that another species existed. He says, "I am particular in noticing this, because the wings of Mr. Kirby's *C. Tritici* are not spotted, nor are any individuals that I have seen; and excepting the *C. pictipennis*, which is larger, I know of no species of the genus with spotted wings."

The species under consideration, may appropriately be named and characterized as follows:

Cecidomyia cerealis. Pale orange; tips of tarsi black; wings hyaline, with six dusky spots, two only based on the inner margin; apex of anal nervure immaculate. Length 0.05.

Specimens have been taken almost weekly, from the middle of June till the fore part of September, in fields of flowering wheat, among the grass of plats contiguous to dwellings, and upon the windows of houses. I do not doubt but its habits are very similar

and perhaps identical with those of the *Tritici*, and that in proportion to its numbers it is equally destructive. The investigations of another year, may, I hope, enable me to furnish something more definite upon this most interesting subject.

SPECIES RESEMBLING THE WHEAT-FLIES.

CECIDOMYIA CALIPTERA: C. THORACICA: C. TERGATA.

We have what appear to be several species of Cecidomyides, allied to our wheat-flies in size, in the number and form of the joints of the antennæ, and more or less in the colors of their bodies. Among objects so exceedingly minute, and so closely related to each other, a most patient and critical study of a large collection of specimens, in their recent as well as their dried state, is indispensable, in order to trace out with accuracy and define with precision each of these species. Perplexity and confusion will be the inevitable result of a hasty or superficial performance of a work of this character. It is hence that I shall at present venture to name and characterize but three of these species, whose marks are so evident and distinct as to render their recognition comparatively easy, yet whose colors are so analogous to those of the two insects above described that they would be confounded with them by ordinary observers, unless aware of their distinctive marks. I am only acquainted with these species in their perfect state.

From the middle of July to the first of September, a number of specimens were taken, of a species intimately allied to the spotted-winged wheat-fly. The body, however, is more deeply colored, being to a greater or less degree tinged with red, and the thorax both above and on the sides is of a fulvous-brown shade. It may be readily distinguished from the *cerealis* by its tarsi, the tips of which are of the same pale yellowish hue as the legs, and yet more readily by the spots on its wings, which are seven in number (Plate, fig. *l*). These spots are similarly placed with those of the wheat-fly, except on the under margin of the wing, where the present species has three in number. One of these is situated on the apex of the middle nerve, a second one on the apex of the anal nerve, and a third at the axilla or base of the anal cell. These spots, though smaller, are equally conspicuous with those of the *cerealis*, being commonly of a deeper shade than those possess which are based on

the exterior margin. The two species may at once be discriminated from each other by observing the space about the apex of the anal nerve; this is perfectly hyaline in the wheat-fly, and clouded in the species under consideration, to which the following name and essential marks may be assigned:

Cecidomyia caliptera. Orange-red; tarsi whitish to their tips; wings hyaline, with seven dusky spots, three based on the inner margin, the middle one being on the apex of the anal nerve.
Length 0.05.

A few specimens occurred to my notice about the middle of the month of August, having the abdomen more tinged with red than in the wheat-flies, but commonly fading, when preserved, to a flesh-color or dull yellow; the thorax brown or blackish above, its sides dull yellow; legs blackish except at their bases, and poisers of the same hue; wings dusky, with their nervures more distinctly marked than in the wheat-flies. I would propose for this species a name alluding to the contrast between the color of the thorax and of the abdomen, in a dorsal view of the insect (Plate, fig. 8).

Cecidomyia thoracica. Red: thorax above blackish-brown: legs and poisers blackish: wings dusky.
Length 0.05.

A much more abundant species, and very closely related to the preceding, occurs from the last of July till the middle of September, and perhaps later. Its legs are dusky, but not of so deep a tint as those of the *thoracica*, from which, moreover, it is readily distinguished by having invariably a fulvous-brown or blackish spot at the base of the abdomen on its upper side. The base and sides of the thorax are of the same color with the abdomen, namely, red, or in old specimens dull pale yellow; the upper side, forward of the scutel, being brown. This species (Plate, fig. 5), may be named and characterized as follows:

Cecidomyia tergata. Red: thorax anteriorly and spot at base of tergum brown: wings, legs and poisers dusky.
Length about 0.06.

Each of the preceding appear to be quite distinct from any of the European species that have been described.

The history of the insect which has now been considered, presents some very singular and deeply interesting traits. Far back in the vista of years we see it a powerful depredator: anon it sinks into

obscurity and becomes wholly forgotten. After a lapse of time, a person observes a minute worm in the ears of wheat which he apprehends will do mischief. Another sees it, and for a time is persuaded that it does his crops no damage whatever. A student has his curiosity so far excited that he closely investigates its operations, and records the results of his observations, estimating that in one field twenty bushels of grain, probably a fifteenth part of the crop, had been destroyed. How little is there here to excite alarm. How many fortuitous circumstances annually occur which cause us greater losses. And now, year after year rolls away, till one generation of the human race has nearly passed out of existence, yet nothing, nothing further is heard of this matter. That student bids fair to sink into the grave, perhaps with the apprehension that posterity will pronounce his early labors tinged with the exaggerations of a juvenile enthusiasm. But lo, a new epoch unexpectedly opens before us. Suddenly bursting from its long obscurity, it rushes forth with resistless vigor. It menaces the population of entire districts with bankruptcy, and even threatens to wrest from man his "staff of life." More marvellous still, it overleaps the ocean's vast expanse, it plants itself far in the interior of another continent, and there runs a career surpassing in the severity of its havoc all that had been known of it in its native haunts. And what is this potent enemy? A diminutive gnat, seemingly too trivial to merit a moment's notice, too impotent to excite an uneasy thought!—a tiny midge, so puny as to flee from the light of day, so fragile as to be dismembered by a breath, or crushed by the drop of a pin! Yet man, the vaunted "lord of creation" stands dismayed and powerless before it. He sees his property wasted to the amount of millions, yet is incapable of resorting to any measure to mitigate the severity of its devastations, or of erecting the slightest barrier to check it in its triumphant progress!

We close this account, then, with the hope that what has now been written may be of some avail, not merely in giving the agriculturist a more intimate knowledge of one of his greatest enemies, but also in enabling the general reader more duly to appreciate the vast value of a branch of natural science but slightly esteemed and but little pursued in this country. Since there is not one of our cultivated plants, not one of our forest or fruit trees, not one of our domesticated animals but is frequently attacked and liable to be de-

stroyed by one or more of that myriad of beings which belong to the insect races of our land, how very important is it that the habits of each one of these should be fully and accurately investigated. Mayhap many of them, minute though they are, and apparently feeble and innoxious, may one day, like the wheat-fly, become powerful despoilers of our property and inflict upon us most severe calamities. It is only by a familiar acquaintance with them that we can hope to avert from us such disasters.

Salem, N. Y., Feb. 6, 1846.

DESCRIPTION OF THE PLATE.

Fig. 1. Clear-winged wheat-fly, *Cecidomyia Tritici.*

Fig. 2. Spotted-winged wheat-fly, *Cecidomyia cerealis.*

Fig. 3. *Cecidomyia thoracica.*

Fig. 4. Male of the clear-winged wheat-fly.

Fig. 5. *Cecidomyia tergata.*

Fig. 6. Wheat-fly at rest, with its wings in their natural position.

Fig. *a.* Kernel of wheat, its chaff parted down to show the worms in their usual situation.

Fig. *b.* A mature worm or larva, highly magnified.

Fig. *c.* Wheat-head, with the chaff at * * * as bent down by the yellow-bird in feeding upon the worms, the kernels remaining at ††.

Fig. *e.* Part of a male antenna.

Fig. *f.* Tip of the abdomen, with the ovipositor drawn out (from Curtis].

Fig. *g.* Foot of a wheat-fly, highly magnified to show its several joints.

Fig. *h.* Part of a female antenna.

Fig. *i.* Wheat-fly in its natural size.

Fig. *k.* Magnified wing of *Cecidomyia cerealis.*

Fig. *l.* Magnified wing of *Cecidomyia caliptera.*

ERRATA.

12, line 9, insert *a dash* in place of *the period.*

24, line 11, for "they directed" read "they are directed."

30, line 18, for "the one terminal" read "the terminal one."

line 22, for "forward to" read "forward of."

line 36, for "with twenty-four" read "with the twenty-four."

35, line 32, for "under margin" read "inner margin."